

R E M A R K S

Reconsideration of this application, as amended, is respectfully requested.

THE TITLE

The title has been amended to more clearly indicate the nature of the invention to which the claims are directed, as required by the Examiner.

RE: THE ALLOWABLE SUBJECT MATTER

The Examiner's allowance of claims 5-7 and the Examiner's indication of the allowability of the subject matter of claims 4 and 9 are respectfully acknowledged.

Claims 4-7 and 9 have been amended to make some minor grammatical improvements. No new matter has been added, and no new issues with respect to patentability have been raised. It is respectfully submitted, moreover, that the amendments to claims 4-7 and 9 are clearly not related to patentability, and do not narrow the scope of the claims either literally or under the doctrine of equivalents. Accordingly, it is respectfully submitted that claims 5-7 remain in condition for allowance.

Claims 4 and 9, however, have not been rewritten in independent form at this time since, as set forth in detail hereinbelow, it is respectfully submitted that their parent claim 1, as amended, now also recites allowable subject matter.

THE SPECIFICATION

The specification has been amended to correct some minor informalities of which the undersigned has become aware. In particular, the specification has been amended to correct references to the auxiliary diaphragm portion "22b" to correctly refer to reference "21b" and to correct references to the through-hole "22c" to correctly refer to reference "21c" to better accord with Figs. 7 and 8. The specification has also been amended to make some minor grammatical improvements. No new matter has been added, and it is respectfully requested that the amendments to the specification be approved and entered.

RE: THE REJECTED CLAIMS

Claim 1 has been amended to clarify that the diaphragm is a thin diaphragm made of brittle material, as supported by the disclosure in the specification at, for example, page 8, lines 10-12, and to clarify that the strain resistance gauge is in a surface thereof, as supported by the disclosure in the specification at, for example, page 14, line 22 to page 15, line 9.

In addition, claims 1-3 and 8 have been amended to make some minor grammatical improvements and to correct some minor antecedent basis problems so as to put them in better form for issuance in a U.S. patent.

No new matter has been added, and it is respectfully requested that the amendments to the claims be approved and entered.

It is respectfully submitted, moreover, that amended claim 1 and claims 2, 3 and 8 depending therefrom patentably distinguish over USP 6,019,135 ("Onishi") under 35 USC 102 as well as under 35 USC 103.

According to the present invention as recited in amended independent claim 1, a pressure sensor device is provided which comprises a thin diaphragm made of brittle material, in which a strain resistance gauge is formed in a surface thereof, and a stopper member including a concave portion comprising a curved surface parallel to a surface formed by displacement of the diaphragm, wherein the concave portion is disposed so as to face said diaphragm.

Thus, the present invention as recited in claim 1 relates to a pressure sensor device having a thin diaphragm (sensor chip) which has a strain resistance gauge formed in its surface, and which is made of brittle material. For example, as described in the specification at page 8, lines 10-12, the diaphragm is formed of a brittle material such as silicon (Si) and glass. As recited in amended claim 1, the diaphragm recited in claim 1 is "thin." For example, as disclosed in the specification at page 16, lines 16-19, the diaphragm may have a diameter of about 2 mm and a thickness of about 30 μm in order to carry out functions as a

pressure sensor. Still further, the present invention as recited in claim 1 also relates to a construction for preventing breakdowns of the diaphragm (sensor chip). See the disclosure in the specification at, for example, page 6, lines 11-21.

Specifically, with the structure of the present invention as recited in amended independent claim 1, when the diaphragm is applied with high pressure, the functions of the sensor device are protected. Thus, with the structure recited in amended independent claim 1, a thin diaphragm made of a brittle material, in which a strain resistance gauge is formed in a surface thereof, is protected.

As shown in FIG. 13 of the application, conventional sensor devices have been protected by providing pressure-buffer diaphragms (4a, 4b, 6) interposed in a pressure-transmitting path to prevent a diaphragm-type sensor chip (1) from being applied with high pressure. By regulating the displacement amount of the diaphragms (4a, 4b, 6), an undesirable application of high pressure on the sensor chip (1) is avoided.

The present invention as recited in claim 1 eliminates the need for the buffer diaphragm (6) by preventing breakdowns of the thin diaphragm (sensor chip) made of brittle material. That is to say, it is possible to directly receive high process pressure in the thin diaphragm (sensor chip) made of brittle material, and this eliminates the need for conventional pressure-receiving diaphragms (4a, 4b) and in particular the center diaphragm (6)

provided to protect the conventional pressure sensor device. Therefore, with the structure of the present invention, it is not necessary to install the pressure-buffer diaphragms (4a, 4b, 6) into a pressure sensor device, such as a differential pressure-type pressure sensor and a pressure-transmitting medium, using the diaphragm-type sensor chip (1) as a sensor element. Accordingly, it is possible to downsize the pressure sensor device to a great degree.

It is respectfully submitted that Onishi does not disclose, teach or suggest a pressure sensor device having the structure recited in amended independent claim 1. By contrast, Onishi discloses a high-pressure accumulator (70) in an engine fuel system, in which a diaphragm (86). That is, Onishi relates to a stopper construction that is provided to a high-pressure vessel, which seals the perimeter portion of a flexible disk-shaped metal diaphragm to form a high-pressure chamber, to prevent the diaphragm from being broken. In particular, a diaphragm of this type is installed in a high-pressure fuel injection system of a gasoline or diesel engine to be used for absorbing surges of fuel pressure.

More specifically, it is respectfully pointed out that Onishi does not disclose a diaphragm made of brittle material. Instead, discloses that the diaphragm (86) is a flexible metal diaphragm (column 2, lines 19-20). And it is respectfully submitted that Onishi does not disclose that the flexible metal

diaphragm (86) thereof is a pressure sensor, or a thin diaphragm made of brittle material, in which a strain resistance gauge is formed in a surface thereof, in the manner of the present invention as recited in amended independent claim 1.

Thus, it is respectfully submitted that Onishi merely discloses a pressure-buffer diaphragm, which is installed in a high-pressure accumulator of an engine fuel system. And it is respectfully submitted that, while the structure of Onishi may be useful for preventing of breakdowns of diaphragms such as diaphragms 4a, 4b and 6 shown in Fig. 13 of the present application, Onishi does not disclose, teach or suggest the structure of the present invention which directly prevents the breakdowns of the thin diaphragm (sensor chip) made of brittle material.

In view of the foregoing, it is respectfully submitted that amended independent claim 1 and claims 2, 3 and 8 depending therefrom clearly patentably distinguish over Onishi, under 35 USC 102 as well as under 35 USC 103, along with allowable claims 4 and 9 and allowed claims 5-7.

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Entry of this Amendment, allowance of the claims and the passing of this application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,

/Douglas Holtz/

Douglas Holtz
Reg. No. 33,902

Frishauf, Holtz, Goodman & Chick, P.C.
220 Fifth Avenue - 16th Floor
New York, New York 10001-7708
Tel. No. (212) 319-4900
Fax No. (212) 319-5101

DH:rjl/iv